Analog 410 Series

TDM410

User Manual

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Safety Certification and Agency Approvals

Safety: US/CSA 60950
IEC 60950
EN 60950

Other:

CE Mark
2002/95/EC Restrictions on Hazardous Substances (RoHS), 2005/747/EC lead free exemption (Annex C)

Telecom:

FCC Part 68, ANSI/TIA-968-A, Including Amendment A1 and A2

Industry Canada IC-CS-03

Australia S002 (POTS line) / S003 (POTS Extn)

TBR-21

EMC:

FCC Part 15 Class A
EN55022/CISPR22 Class A
EN55024

Federal Communications Commission Part 68

This equipment complies with Part 68 of the FCC rules and the requirements adopted by the ACTA. On the back of the Analog 410 Series printed circuit board is a label that contains, among other information, a product identifier in the format US:AAAEQ##TXXXX. If requested, this number must be provided to the telephone company.

A plug and jack used to connect this equipment to the premises wiring and telephone network must comply with the applicable FCC Part 68 rules and requirements adopted by the ACTA.

The REN is used to determine the number of devices that may be connected to a telephone line. Excessive RENs on a telephone line may result in the devices not ringing in response to an incoming call. In most but not all areas, the sum of RENs should not exceed five (5.0). To be certain of the number of devices that may be connected to a line, as determined by the total RENs, contact the local telephone company. For products approved after July 23, 2001, the REN is part of the product identifier that has the format US:AAAEQ##TXXXX. The digits represented by ## are the REN without a decimal point (e.g., 03 is a REN of 0.3).

If your Analog 410 Series card causes harm to the telephone network, the telephone company may notify you in advance that temporary discontinuance of service may be required. But if advance notice is not practical, the telephone company will notify you as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

The telephone company may make changes in its facilities, equipment, operations or procedures that could affect the operation of the equipment. If this happens, the telephone company will provide advance notice in order for you to make necessary modifications to maintain uninterrupted service.

If you experience problems with your Analog 410 Series card, contact Digium, Inc. at 1.877.DIGIUM.1 (1.877.344.4861) for repair and/or warranty information. If the equipment is causing harm to the telephone network, the telephone company may request that you disconnect the equipment until the problem is resolved.

Connection to party line service is subject to state tariffs. Contact the state public utility commission, public service commission, or corporation commission for information.

Federal Communications Commission Part 15

This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

Industry Canada

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulation.
Cet appareil numerique de la class A respecte les exigences du Reglement sur le Material Brouilleur du Canada.

Introduction to Analog 410 Series Documentation

This manual contains product information for the Analog 410 Series card. Be sure to refer to any supplementary documents or release notes that were shipped with your equipment. The manual is organized in the following manner:

Chapter/ Appendix	Title	Description
1	Overview	Identifies the card and type of modules you received with your Analog 410 Series card. This chapter covers applications and uses of the Analog 410 Series card in the real world.
2	Card Installation	Provides instructions for installing the card in your PC, acquiring correct drivers, and checking device compatibility.
3	Configuration	Provides examples for configuring dial plan options.
4	FXS and FXO Explained	Describes the FXO (Foreign Exchange Office) and FXS (Foreign Exchange Station) modules and their significance.
5	Troubleshooting	Explains resolutions to common problems and frequently asked questions pertaining to card installation and usage.
A	Pin Assignments	Lists the connectors and pin assignments.
B	Specifications	Details card specifications.
C	Glossary and Acronyms	A list of terms and acronyms used throughout this manual.

Symbol Definitions

Caution statements indicate a condition where damage to the unit or its configuration could occur if operational procedures are not followed. To reduce the risk of damage or injury, follow all steps or procedures as instructed.

The ESD symbol indicates electrostatic sensitive devices. Observe precautions for handling devices. Wear a properly grounded electrostatic discharge (ESD) wrist strap while handling the device.

The Electrical Hazard Symbol indicates a possibility of electrical shock when operating this unit in certain situations. To reduce the risk of damage or injury, follow all steps or procedures as instructed.

Important Safety Instructions

User Cautions

Warning
This card must be used with the PC lid screwed down. Telecommunications network voltages exist inside the PC! The PC must be shut down and telecommunications line connection shall be removed before opening the PC.

Electrical Shock.
To reduce the risk of injury, damage to the unit or your equipment, do not attempt to touch the modules while they are powered. The case should be securely closed before power is applied to the unit.

Alarm Dialing Equipment.
If your home has specially wired alarm equipment connected to the telephone line, ensure the installation of the Analog 410 Series does not disable your alarm equipment. If you have questions, consult your telephone company or a qualified installer.

Servicing.
Do not attempt to service this card unless specifically instructed to do so. Do not attempt to remove the card from your equipment while power is present. Refer servicing to qualified service personnel.

Water and Moisture.
Do not spill liquids on this unit. Do not operate this equipment in a wet environment.

Heat.
Do not operate or store this product near heat sources such as radiators, air ducts, areas subject to direct, intense sunlight, or other products that produce heat.

Caution.
To reduce the risk of fire, use only No. 26 AWG or larger telecommunication wiring for network connections.

User Cautions

Caution.
This card is not intended for home use. It must be used in restricted access locations and installed in UL Listed I.T.E. only.

Static Electricity.
To reduce the risk of damaging the unit or your equipment, do not attempt to open the enclosure or gain access to areas where you are not instructed to do so. Refer servicing to qualified service personnel.

Save these instructions for future reference.

Service Personnel Cautions

Warning.
This card must be used with the PC lid screwed down. Telecommunications network voltages exist inside the PC! The PC must be shut down and telecommunications line connection shall be removed before opening the PC.

Electrical Shock.
To reduce the risk of injury, damage to the unit or your equipment, do not attempt to touch the modules while they are powered. The case should be securely closed before power is applied to the unit.

Servicing.
Disconnect telecommunications network cable before opening the cover or removing the card from the motherboard.

Labeling.
For safety reasons, only connect equipment with a Telecommunications Compliance label. This includes customer equipment previously labelled **Permitted** *or* **Certified.**

Caution.
Only connect regulatory equipment (approved for use in your specific country) to the telecommunications network voltage circuit ports.

Service Personnel Cautions

Caution.
This card is not intended for home use. It must be used in restricted access locations and installed in UL Listed I.T.E. only.

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Chapter 1
Overview

The Analog 410 Series cards are versatile devices used for connecting your phone network to the PSTN (Public Switched Telephone Network) world. This is accomplished through phone lines connected to the FXO (Foreign Exchange Office) ports and phones connected via the FXS (Foreign Exchange Station) ports. The cards allow Asterisk software to connect to your phone network, creating an office type telephony environment.

There are a variety of applications where an Analog 410 Series (such as the TDM410) proves useful. An example is provided in the following figure.

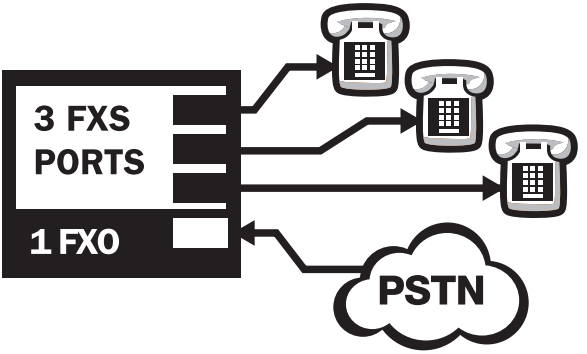


Figure 1: Sample Card Application

What is Asterisk®?

Asterisk is the world's leading open source telephony engine and tool kit. Offering flexibility unheard of in the world of proprietary communications, Asterisk empowers developers and integrators to create advanced communication solutions...for free. Asterisk® is released as open source under the GNU General Public License (GPL), and it is available for download free of charge. Asterisk® is the most popular open source software available, with the Asterisk Community being the top influencer in VoIP.

Asterisk as a Switch (PBX)

Asterisk can be configured as the core of an IP or hybrid PBX, switching calls, managing routes, enabling features, and connecting callers with the outside world over IP, analog (POTS), and digital (T1/E1) connections.

Asterisk runs on a wide variety of operating systems including Linux, Mac OS X, OpenBSD, FreeBSD and Sun Solaris and provides all of the features you would expect from a PBX including many advanced features that are often associated with high end (and high cost) proprietary PBXs. Asterisk's architecture is designed for maximum flexibility and supports Voice over IP in many protocols, and can interoperate with almost all standards-based telephony equipment using relatively inexpensive hardware.

Asterisk as a Gateway

It can also be built out as the heart of a media gateway, bridging the legacy PSTN to the expanding world of IP telephony. Asterisk's modular architecture allows it to convert between a wide range of communications protocols and media codecs.

Asterisk as a Feature/Media Server

Need an IVR? Asterisk's got you covered. How about a conference bridge? Yep. It's in there. What about an automated attendant? Asterisk does that too. How about a replacement for your aging legacy voicemail system? Can do. Unified messaging? No problem. Need a telephony interface for your web site? Ok.

Asterisk in the Call Center

Asterisk has been adopted by call centers around the world based on its flexibility. Call center and contact center developers have built complete ACD systems based on Asterisk. Asterisk has also added new life to existing call center solutions by adding remote IP agent capabilities, advanced skills-based routing, predictive and bulk dialing, and more.

Asterisk in the Network

Internet Telephony Service Providers (ITSPs), competitive local exchange carriers (CLECS) and even first-tier incumbents have discovered the power of open source communications with Asterisk. Feature servers, hosted services clusters, voicemail systems, pre-paid calling solutions, all based on Asterisk have helped reduce costs and enabled flexibility.

Asterisk Everywhere

Asterisk has become the basis for thousands of communications solutions. If you need to communicate, Asterisk is your answer. For more information on Asterisk visit http://www.asterisk.org or http://www.digium.com.

Chapter 2
Card Installation

This chapter provides the following information:

- **Unpacking the Card** on page 19
- **Shipment Inspection** on page 20
- **Module Identification** on page 20
- **FXS and FXO Connection** on page 24
- **Hardware Installation** on page 26
- **Software Installation** on page 29

Note: The Analog 410 Series card installation instructions are written so that they will apply to any card in the series. Examples and card specific information are included as needed.

Unpacking the Card

When you unpack your card, carefully inspect it for any damage that may have occurred in shipment. If damage is suspected, file a claim with the carrier and contact your reseller from which the card was purchased, or Digium Technical Support at 1.256.428.6161. Keep the original shipping container to use for future shipment or proof of damage during shipment.

Note: Only qualified service personnel should install the card. Users should not attempt to perform this function themselves. The installer must ensure that the equipment is permanently connected equipment, pluggable type B or connected to a socket-outlet that has been checked to ensure that it is reliably earthed in accordance with the National Electrical Code.

This card is intended for installation in a Restricted Access Location (RAL) only.

Shipment Inspection

The following items are included in shipment of an Analog 410 Series analog card:

- A TDM410 card
- A combination of FXO and/or FXS modules

Module Identification

The Analog 410 Series cards ship with FXO and/or FXS modules in place. These are identified by their color. Take a moment to identify which modules were shipped with your card.

- FXO (Foreign Exchange Office) modules are Red
- FXS (Foreign Exchange Station) modules are Green

See Figure 2 on page 22 for an example of the TDM410 card shown with two of each single module.

The Analog 410 Series cards may also be combined with Digium's hardware-based echo canceler, model VPMADT032.

Port Identification

Each card consists of four RJ11 ports located on the bracket. Each port correlates to a single module port (containing either FXO or FXS modules). The ports are numbered in sequence from one to four. The top port is Port 1 and the bottom port is Port 4. See Figure 2 on page 22 for appropriate identification of these ports. The port identification is the same for all cards in this series.

It is important to identify the type and location of your Analog 410 Series modules. You will need this information during the Asterisk configuration.

The ports available for use on the Analog 410 Series cards are continuous. The cards can accept 4 single modules, for a total of 4 ports. The single module ports are identified on the card and their corresponding RJ11 ports are identified below. The RJ11 port available for use will be the port corresponding to the location of the module on the card. The following ports correspond to the single module ports as shown in Figure 2.

- RJ11 Port 1 is used by Single Module Port 1
- RJ11 Port 2 is used by Single Module Port 2
- RJ11 Port 3 is used by Single Module Port 3
- RJ11 Port 4 is used by Single Module Port 4

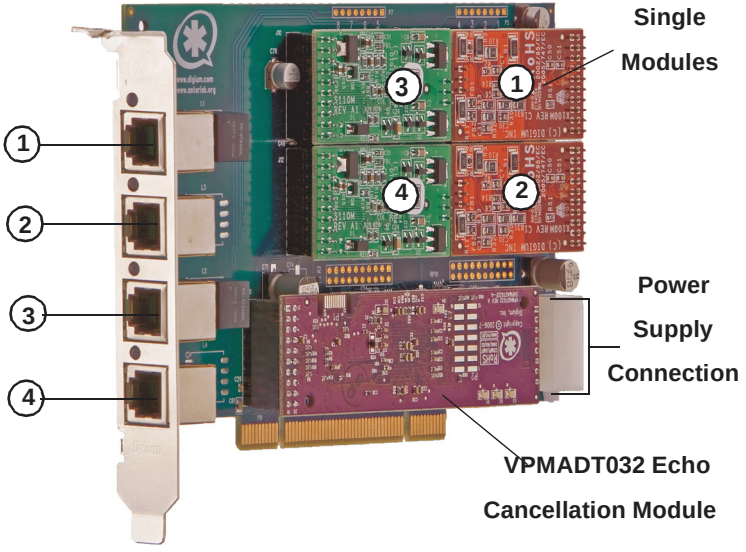


Figure 2: TDM410 Card with Four Single Modules

There are multiple configurations in which an Analog 410 Series card may be purchased. Each configuration consists of a combination of single modules. See Table 1 on page 23 for a list of the most common TDM410 configurations. The lists are not complete, but rather an example of the configurations available.

It is easiest to identify your card by understanding the naming scheme for each card. The second digit provides the number of FXS modules present on the card. The third digit provides the number of FXO modules present on the card.

Table 1: Example TDM410 Card Configurations

Card ID	FXO/FXS Ports
TDM411B	1 FXO module
TDM404B	4 FXO modules
TDM422B	2 FXS and 2 FXO modules
TDM440B	4 FXS modules

FXS and FXO Connection

The Analog 410 Series cards provide four RJ11 connectors for access to the FXS and/or FXO modules installed in the available slots. The diagram in Table A-1 on page 43 provides the pinout for this connector.

Caution.
Only qualified service personnel should continue with hardware installation and configuration of the Analog 410 Series card. Users should not attempt to perform these functions themselves.

Slot Compatibility

Check the type of card you received to be sure it is compatible with your PCI slot. To determine which slot you have, identify it by comparing it to those shown in Figure 3 on page 25.

Slot Number:

0: AGP Pro Slot
1: 64-bit 5.0 volt PCI Slot
2: 64-bit 3.3 volt PCI Slot
3: 32-bit 5.0 volt PCI Slot
4: PCI Express Slot

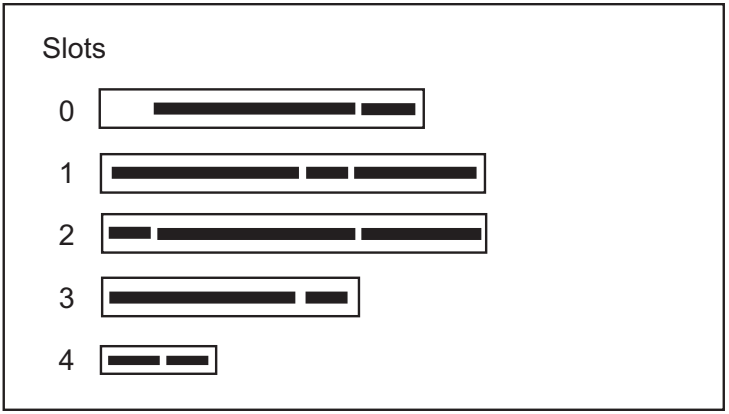


Figure 3: Motherboard PCI Slots

The TDM410 card is a 32-bit 33MHz card keyed for universal 3.3 volt or 5.0 volt operation and works in any PCI 2.2 (or greater) compliant slot. This means that in the motherboard shown in Figure 3, the TDM410 card will fit into Slots 1, 2, or 3 (PCI slots) but **will not** fit into Slot 0 (AGP slot) or Slot 4 (PCI Express slot).

Hardware Installation

1. Now that you are acquainted with your card, power down your computer and unplug it from its power source.
2. Attach a static strap to your wrist and open the case.
3. Remove the bracket place holder and insert the card into a PCI (TDM410) slot. See Figure 4.

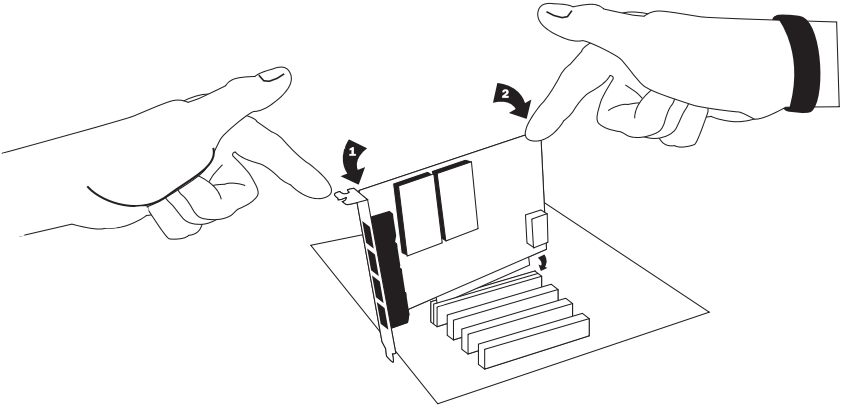


Figure 4: Insert the Card

4. If your card has any FXS modules, you will also need to connect the power cable from your computer's power supply to the back of the card. Insert a four-pin 12 volt connector (disk drive power supply cable, e.g. hard drive) into the white plastic connector on the rear of the card. See Figure 5.

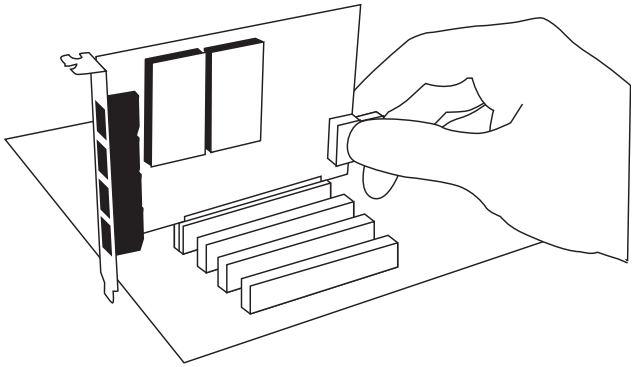


Figure 5: Connect Power for FXS Modules

Many modern PCs and servers do not have either spare or any 12V power connectors. If you have FXS modules on your card and your computer does not have power cables available, then power must be provided to the card by an alternate means. Digium provides a solution to this problem with the optional PWR2400B (available separately). This card is essentially a PCI bracket assembly that takes power from an external DC power supply and routes it to two 15" power cables inside the computer. You must have an available bracket slot to use the PWR2400B (either PCI, PCI Express or AGP).

A strap on the PWR2400B card allows the two power cables to take power from the same DC supply. The PWR2400B does not connect to any bus inside the computer. It may be used wherever there is an available PCI-size bracket such as a PCI slot, PCI Express slot, or AGP slot.

Note: The PWR2400B is not intended to supply power to any other device, it is intended only to be used with UL Listed Digium Analog 410 Series cards.

5. Replace the cover to your computer.

Electrical Shock.
To reduce the risk of injury, damage to the unit or your equipment, do not attempt to apply power to the unit while the case is open.Personal injury or damage to the unit could occur if the modules are touched while powered is applied.

6. Plug all outside phone lines to the FXO (red) ports and connect all phones to the FXS (green) ports as needed. See Table A-1 on page 43 for the pin assignments.

Caution.
This unit must be connected to the Telecommunications Network in your country using an approved line cord, e.g.: for Australia use only line cords complying with ACA Technical Standard TS008.

Caution.
Only connect regulatory equipment (approved for use in your specific country) to the telecommunications network voltage circuit ports.

Software Installation

Digium hardware requires drivers and libraries that are integrated with the Linux kernel. The Analog 410 Series cards are only supported under Linux. Digium, Inc. recommends Debian, Fedora, and Red Hat. However, many other distributions are supported by Digium Technical Support. You can obtain the source code from downloads.digium.com. Detailed instructions are provided in this section.

> **Note:** Please refer to asterisk.org for an introduction to Asterisk, its configuration and features, and set up and use of Zaptel channels.

To install your Analog 410 Series card, you will need:

- Full Linux kernel 2.6 (or later) source code.
- Development libraries and headers for libncurses (only necessary for Asterisk).
- Development libraries and headers for zlib and openssl.
- GCC and standard build tools.
- Development libraries and headers for libnewt (only necessary for Zaptel).
- If you are using the 1.2.x series of Asterisk and Zaptel, you will need Asterisk 1.2.26 or newer, and Zaptel 1.2.23 or newer. If you are using the 1.4.x series of Asterisk and Zaptel, you will need Asterisk 1.4.17 or newer and Zaptel 1.4.8 or newer. If you are using Asterisk Business Edition, you will need version C.1 or newer.

  Note: It is recommended that you use the most recent version of the Asterisk and Zaptel distributions for the best results.

  Note: If you already have both Asterisk and Zaptel installed, you will need to upgrade to the latest version of both.

1. Check your **lspci** PCI device listing. Boot the computer into Linux. After the machine has loaded, log in and execute the following:

```
# lspci -n | grep d161
```

Confirm your **lspci** PCI device listing by scanning for the following information in the output screen:

```
0000:01:00.0 0200:d161:<device identifier>
```

In the device listing shown above, <device identifier> will be populated with one of the identifiers listed in the table below. If an identifier is not displayed, then your machine is not PCI 2.2 (or higher) compatible and the card will not work with your equipment.

Table 2: Device Identifiers

Model	Identifier
TDM410	8005

2. Download the latest Zaptel drivers to your /usr/src directory. The Zaptel drivers are accessible via http from http://downloads.digium.com/pub/telephony/zaptel/.

3. Expand the downloaded tarball and install the drivers. Substitute the version of Zaptel you are using for the X.X in the command lines below:

```
#tar -zxvf zaptel-1.X.X.tar.gz
#cd zaptel-1.X.X
#make clean
#./configure (applies to 1.4.X only)
#make menuselect (applies to 1.4.X only if you wish
to customize the install)
#make
#make install
```

4. Download the latest released version of Asterisk, either 1.2.26 (or later) or 1.4.17 (or later). If you are using Asterisk Business edition, it should be version C.1 or later. Asterisk can be downloaded from http://downloads.digium.com/pub/telephony/asterisk. You will need access to the Business Edition portal in order to obtain the latest version of Business Edition.
5. Expand the downloaded tarballs. Substitute the version of Asterisk you are using with the X.X in the command lines below.

```
# tar -zxvf asterisk-1.X.X.tar.gz
# cd asterisk-1.X.X/
# make clean
# ./configure (applies to 1.4.X only)
# make menuselect (applies to 1.4.X only if you wish
to customize the install)
# make
# make install
```

If you don't already have configuration files installed, you can type "make samples" to install the default sample configuration files. This will override any sample files you previously installed.

Your installation of Zaptel and Asterisk should now be complete.

If the build fails, it may be because you are missing one of the build dependencies, the kernel source, or development tools. Feel free to contact your reseller where the card was purchased, or e-mail Digium Technical Support via support@digium.com for assistance.

Note: Complete instructions for installing Asterisk are available at www.asterisk.org.

Zaptel Configuration

The Zaptel Configuration file, /etc/zaptel.conf, needs to be edited in order for your Analog 410 Series card to work properly. When configuring the settings in zaptel.conf, you are configuring the port signalling, not the port type. FXO ports use FXS signalling, and FXS ports use FXO signalling. If you have an FXS port in position 1 and an FXO port in position 4, your zaptel.conf will look like:

```
fxs_ks=1
fxo_ks=4
loadzone=us
defaultzone=us
```

The following steps are necessary for Zaptel configuration:

1. If your card has any red FXO modules, add the following:

   ```
   fxsks
   ```

   This uses kewl start signalling which is loop start with disconnect supervision. For example, a TDM440B card would be configured as follows:

   ```
   fxsks=1,2,3,4
   ```

   Note: You should have identified the type of Analog 410 Series card you have when you received it. If you are not sure, refer to **Module Identification** on page 20 for assistance.

2. If your card has any green FXS modules, add the following:

```
fxoks
```

This uses kewl start signalling which is loop start with disconnect supervision. For example, a TDM440 card would be configured as the following:

```
fxoks=1,2,3,4
```

An example TDM422B card configuration would be:

```
fxoks=1,2
fxsks=3,4
```

3. Set your loadzone and default zone for your country. If you are not in the United States, you will want to change the default configuration from **US** to your own two letter country abbreviation. Save the file and return to the command line.

```
#modprobe wctdm24xxp
#ztcfg -vv
```

Note: The Analog 410 Series cards use the same driver for this setting as the TDM2400.

4. Confirm the card configuration by initiating a dmesg command. The output will identify the card type (such as TDM410), as well as the number of FXO and FXS modules present.

   Note: You will make changes to the configuration files to set up your dial plan and customize Asterisk to suit your particular needs. These changes are stored in the /etc/zaptel.conf configuration file.

Chapter 3
Configuration

This chapter provides sample configurations to demonstrate customizing the Asterisk software to meet your individual needs. Each section explains basic options as examples. Once you have familiarized yourself with the samples, you can edit the configuration files to meet your specific needs.

> **Note:** Only qualified service personnel should install the card. Users should not attempt to perform this function themselves.

General Options

Open the **zapata.conf** file from the **/etc/asterisk/** directory.

The following is a sample configuration for a TDM422E card. You can place this at the bottom of your **zapata.conf** file.

```
;General options
usecallerid=yes
hidecallerid=no
callwaiting=yes
threewaycalling=yes
transfer=yes
echocancel=yes
echocancelwhenbridged=yes
rxgain=0.0
txgain=0.0
;FXS Modules
```

```
Group=1
signalling=fxo_ks
context=Internal
channel=1-2

;FXO Modules
Group=2
echocancel=yes
signalling=fxs_ks
context=Incoming
channel=3-4
```

Users of Digium's hardware echo cancellation module, the VPMADT032, should set the echocancel option to "yes." The module will automatically configure itself to run at full capacity, 1024 taps (128ms), on each channel.

Users without the VPMADT032 using open source echo cancelers included with Zaptel should configure echocancel to the values 128 (16ms) or 256 (32ms). Setting "yes" will default the option to 128 (16ms).

Users who have not purchased the Analog 410 series card with the hardware echo cancellation module are encouraged to take advantage of Digium's High Performance Echo Canceler software. This commercially licensed software, which is made available at no charge to in-warranty Digium analog interface card customers, provide toll quality echo cancellation, performed on the host CPU, at up to 1024 taps (128ms) per channel. For further details about HPEC, please refer to the Digium website here:

http://www.digium.com/en/products/software/hpec.php

When HPEC is enabled, users may set the value of the echocancel parameter to any of the following values:

128 - 16ms
256 - 32ms
512 - 64ms
1024 - 128ms

> **Note:** Higher values will result in dramatically increased CPU consumption. In order to optimize system performance, users are encouraged to choose the minimum value required to cancel their echo.

Voicemail

Open **voicemail.conf** and find the following line at the bottom:

```
[default]
1234 => 4242,Mark Spencer,root@localhost
```

In this example, **1234** is the mailbox number, **4242** is the password, **Mark Spencer** is the person's name, and **root@localhost** is his email address.

You can add extensions by adding the following:

```
1000 => 1234,Moose Member,moose@digium.com
2000 => 1234,Bill Savage,bsavage@digium.com
```

Dial Plan

Open **extensions.conf**, which contains a large, complex sample dial plan. In this step, you will configure a basic dial plan which will allow you to send and receive calls. Go to the bottom of the file and add the following lines:

```
[Internal]
exten => 1000,1,Dial(zap/1,20,t)
exten => 1000,n,Set(CURRENT_EXTEN=${EXTEN})
exten => 1000,n,Goto(s-${DIALSTATUS},1)


exten => 2000,1,Dial(zap/2,20,t)
exten => 2000,n,Set(CURRENT_EXTEN=${EXTEN})
exten => 2000,n,Goto(s-${DIALSTATUS},1)

; Handle Voicemail
exten => s-NOANSWER,1,Voicemail(${CURRENT_EXTEN},u)
exten => s-BUSY,1,Voicemail(${CURRENT_EXTEN},b)
exten => _s-.,1,Goto(s-NOANSWER,1)

exten => 8500,1,VoiceMailMain()
exten => 8501,1,MusicOnHold()

exten => _9.,1,Dial(Zap/g2/www${EXTEN:1})
exten => _9.,2,Congestion
```

```
[Incoming]
exten => s,1,Answer()
exten => s,n,Set(VM_EXTEN=1000)
exten => s,n,Dial(zap/g1,20,t)
exten => s,n,Goto(s-${DIALSTATUS},1)

exten => s-NOANSWER,1,Voicemail(${VM_EXTEN},u)
exten => s-BUSY,1,Voicemail(${VM_EXTEN},b)
exten => _s-.,1,Goto(s-NOANSWER,1)
```

In this example there are two internal extensions (1000 and 2000), a number to check voicemail (8500), a number to listen to musiconhold, (8501), and a prefix to dial to get an outside line (9). It is configured for incoming calls, and voicemail is routed to mailbox 1000.

Testing Your Configuration

1. Start Asterisk by typing:

   ```
   asterisk
   ```

2. Connect to Asterisk and view the output by typing:

   ```
   asterisk -vvvvr
   ```

3. Dial tone should be present on phones connected to the FXS ports. Test your configuration by placing an outgoing call, placing a call from extension 1 to 2, or receiving an incoming call. Successful completion of these tasks indicates your configuration is working properly.

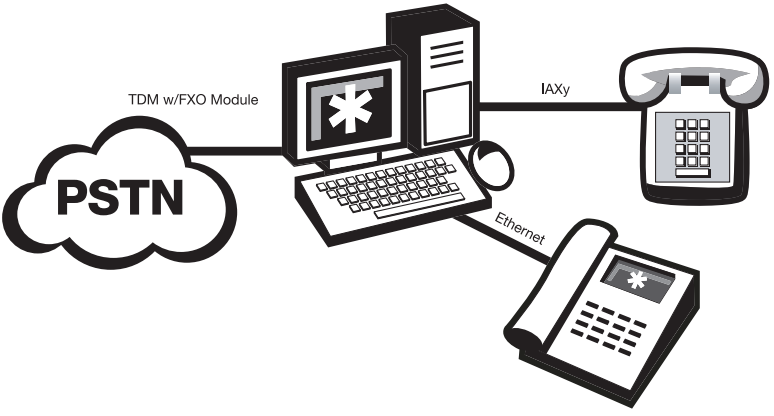


Figure 6: Sample Application

Note: More detailed information is provided on troubleshooting at the Asterisk website (www.asterisk.org) as well as the Digium Knowledge Base (kb.digium.com). You may also obtain assistance by contacting Digium Technical Support at 1.256.428.6161 or visiting the website at www.digium.com.

Chapter 4
FXS and FXO Explained

Identification

There are multiple standard configurations in which an Analog 410 Series card may be purchased. Each configuration consists of one to four FXS and/or FXO modules. These modules are identified by their color.

- **FXS** - Foreign Exchange Station (Green Modules)
- **FXO** - Foreign Exchange Office (Red Modules)

This chapter provides an in-depth review of the two module types and their uses within your Asterisk server.

> **Note:** Only qualified service personnel should install the card. Users should not attempt to perform this function themselves.

FXS Module

The FXS module allows an Analog 410 Series card to initiate and send ringing voltage to an FXO device such as an analog telephone.

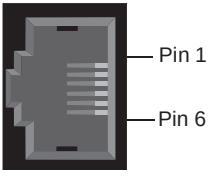
FXO Module

The FXO module allows an Analog 410 Series card to terminate analog telephone lines (POTS). Because of the modular design, you can activate additional ports at any time with more FXS or FXO daughter cards. The FXO module passes all the call features any standard analog telephone line will support. The phone receiving the call is the last FXO device in the chain. When it receives voltage from an FXS device, the phone rings.

Appendix A
Pin Assignments

All eight ports on the Analog 410 Series card's bracket are 6-pin RJ11 ports. The pin assignments are identified in Table A-1.

Table A-1: RJ11 Telco Port Connector

	Pin	Description
	1	Not used
	2	Not used
	3	Tip
	4	Ring
	5	Not used
	6	Not used

Appendix B
Specifications

This appendix provides specifications, required environmental conditions, and maximum power consumption for the 800 Series cards.

Physical (All Cards).

Size: 6.48” × 4.2” × 0.68” (31.19 x 10.67 x 1.72 cm)
PCB size, does not include the PCI bracket.
Check your model carefully to be sure it will accept this PCI card.

Weight: 3.5 oz (99.22 gm) with no modules loaded
Each single module adds 0.4 oz (11.34 gm)
VPMADT032 adds 0.63 oz (17.86 gm)

Interfaces.

Local Loop Access: Industry standard 6-pin RJ-11.

(TDM410) - PCI Bus: 3.3V or 5V bus slot, half-length full-height PCI card, 33MHz minimum bus speed, compliant with PCI 2.2 or greater.
Additional Power: four-pin 12V connector for FXS power supply (required only if FXS modules are installed)

Environment.

Temperature: 0 to 50° C (32 to 122° F) operation
-20 to 65° C (-4 to 149° F) storage
Humidity: 10 to 90% non-condensing

Note: Operating temperature is limited to 0 to 40° C (32 to 104°F) when used with optional PWR2400B Power Bracket

Hardware and Software Requirements.

500-Mhz Pentium III or better
64MB RAM
Available PCI Slot

Power Consumption.

The following table lists the power consumption for both the TDM410 card (and its permutations) .

Note: 3.3 and 5 volt power is taken from the PCI slot. 12 volt power is taken only from the four-pin hard disk drive connector or optional PWR2400B.

Table B-2: Maximum Power Consumption

Model	Power
3.3V All TDM models	4.25W
5.0V All models	0.1W
12V TDM404E	0W
TDM414E into 1REN	0W
TDM411E into 3REN	2.5W
TDM422E into 3REN	3.5W
TDM440E into 3REN	5W

Appendix C
Glossary and Acronyms

ANSI *American National Standards Institute*

An organization which proposes and establishes standards for international communications.

asynchronous

Not synchronized; not timed to an outside clock source. Transmission is controlled by start bits at the beginning and stop bits at the end of each character. Asynchronous communications are often found in internet access and remote office applications.

attenuation

The dissipation of a transmitted signal's power as it travels over a wire.

bandwidth

The capacity to carry traffic. Higher bandwidth indicates the ability to transfer more data in a given time period.

bit

The smallest element of information in a digital system. A bit can be either a zero or a one.

bps *bits per second*

A measurement of transmission speed across a data connection.

broadband

Broadband transmission shares the bandwidth of a particular medium (copper or fiber optic) to integrate multiple signals. The channels take up different frequencies on the cable, integrating voice, data, and video over one line.

channel

A generic term for an individual data stream. Service providers can use multiplexing techniques to transmit multiple channels over a common medium.

Cat5

Category of Performance for wiring and cabling. Cat 5 cabling support applications up to 100 MHz.

Cat5E

Category of Performance for wiring and cabling. Category 5 Enhanced wiring supports signal rates up to 100 MHz but adheres to stricter quality specifications.

CLEC *competitive local exchange carrier*

A term for telephone companies established after the Telecommunications Act of 1996 deregulated the LECs. CLECs compete with ILECs to offer local service. See also *LEC* and *ILEC*.

CO *central office*

The CO houses local switching equipment. All local access lines in a particular geographic area terminate at this facility (which is usually owned and operated by an ILEC).

CPE *customer premises equipment*

Terminal equipment which is connected to the telecommunications network and which resides within the home or office of the customer. This includes telephones, modems, terminals, routers, and television set-top boxes.

DS0 *Digital Signal, Level 0*

A voice grade channel of 64 Kbps. The worldwide standard speed for digitizing voice conversation using PCM (Pulse Code Modulation).

DS1 *Digital Signal, Level 1*

1.544 Mbps in North America (T1) and Japan (J1) -up to 24 voice channels (DS0s), 2.048 Mbps in Europe (E1) - up to 32 voice channels (DS0s). DS1/T1/E1 lines are part of the PSTN.

DS3 *Digital Signal, Level 3*

T3 in North America and Japan, E3 in Europe. Up to 672 voice channels (DS0s). DS3/T3/E3 lines are not part of the PSTN.

DTMF *Dual Tone Multi-Frequency*

Push-button or touch tone dialing.

E1

The European equivalent of North American T1, transmits data at 2.048 Mbps, up to 32 voice channels (DS0s).

E3

The European equivalent of North American T3, transmits data at 34.368 Mbps, up to 512 voice channels (DS0s). Equivalent to 16 E1 lines.

EMI *Electromagnetic Interference*

Unwanted electrical noise present on a power line

full duplex

Data transmission in two directions simultaneously.

FXO *Foreign Exchange Office*

Receives the ringing voltage from an FXS device. Outside lines are connected to the FXO port on your 800 Series card.

FXS *Foreign Exchange Station*

Initiates and sends ringing voltage. Phones are connected to the FXS ports on the 800 Series card.

G *grams*

G.711

The International Telecommunications Union recommendation for an algorithm designed to transmit and receive µ-law PCM voice and A-law at digital bit rate 64 Kbps. This algorithm is used for digital telephone sets on digital PBX.

G.729

The International Telecommunications Union standard for voice algorithm.

H.323

The International Telecommunications Union standard for multimedia communications over packet-based networks.

IAX *Inter-Asterisk eXchange*

The protocol used by Asterisk. It is used to enable VoIP connections between Asterisk servers, and between servers and clients that also use the IAX protocol.

iLBC *internet Low Bitrate Codec*

A free speech codec used for voice over IP. It is designed for narrow band speech with a payload bitrate of 13.33 kbps (frame length = 30ms) and 15.2 kbps (frame length = 20 ms).

ILEC *incumbent local exchange carrier*

The LECs that were the original carriers in the market prior to the entry of competition and therefore have the dominant position in the market.

interface

A point of contact between two systems, networks, or devices.

ISO *International Standards Organization*

LED *light-emitting diode*

Linux

A robust, feature-packed open source operating system based on Unix that remains freely available on the internet. It boasts dependability and offers a wide range of compatibility with hardware and software. Asterisk runs exclusively on Linux.

loopback

A state in which the transmit signal is reversed back as the receive signal, typically by a far-end network element.

MGCP *Media Gateway Control Protocol*

multiplexing

Transmitting multiple signals over a single line or channel. FDM (frequency division multiplexing) and TDM (time division multiplexing) are the two most common methods. FDM separates signals by dividing the data onto different carrier frequencies, and TDM separates signals by interleaving bits one after the other.

MUX *multiplexer*

A device which transmits multiple signals over a single communications line or channel. See multiplexing.

PBX *private branch exchange*

A smaller version of a phone company's large central switching office. Example: Asterisk.

PCI *peripheral component interconnect*

A standard bus used in most computers to connect peripheral devices.

POP *point of presence*

The physical connection point between a network and a telephone network. A POP is usually a network node serving as the equivalent of a CO to a network service provider or an interexchange carrier.

POTS *plain old telephone service*

Standard phone service over the public switched telephone network (PSTN). This service provides analog bandwidth of less than 4 kHz.

PPP *point-to-point protocol*

Type of communications link that connects a single device to another single device, such as a remote terminal to a host computer.

PSTN *public switched telephone network*

A communications network which uses telephones to establish connections between two points. Also referred to as the dial network.

QoS *quality of service*

A measure of telephone service, as specified by the Public Service Commission.

RJ11

A six pin jack typically used for connecting telephones, modems, and fax machines in residential and business settings to PBX or the local telephone CO.

SIP *Session Initiation Protocol*

An IETF proposed standard for setting up sessions between one or more clients. It is currently the leading signaling protocol for Voice over IP, gradually replacing H.323.

T1

A dedicated digital carrier facility which transmits up to 24 voice channels (DS0s) and transmits data at 1.544 Mbps. Commonly used to carry traffic to and from private business networks and ISPs.

T3

A dedicated digital carrier facility which consists of 28 T1 lines and transmits data at 44.736 Mbps. Equivalent to 672 voice channels (DS0s).

TDM *time division multiplexer*

A device that supports simultaneous transmission of multiple data streams into a single high-speed data stream. TDM separates signals by interleaving bits one after the other.

telco

A generic name which refers to the telephone companies throughout the world, including RBOCs, LECs, and PTTs.

tip and ring

The standard termination on the two conductors of a telephone circuit; named after the physical appearance of the contact areas on the jack plug.

twisted pair

Two copper wires commonly used for telephony and data communications. The wires are wrapped loosely around each other to minimize radio frequency interference or interference from other pairs in the same bundle.

V *volts*

VoIP *Voice over IP*

Technology used for transmitting voice traffic over a data network using the Internet Protocol.

W *watts*

Zap

Digium hardware interface.